

PHILOSOPHICAL
TRANSACTIONS.

XXXIV. *Astronomical Observations made at Chislehurst, in Kent, in the course of the Year 1773. By the Rev. Francis Woolaston, LL.B. F. R. S.*

Redde, Mar. 10,
1774. **M**Y having these two last winters communicated to this society, what astronomical observations I had occasionally made in the course of each year, seems to be a call upon me to continue the same now. And I am the rather inclined to do so; because I could wish we were favoured with the correspondent observations of all our worthy brethren, and therefore ought not to be backward to throw in my mite towards a general stock.

My instruments and situation are the same as before described; and the following tables are in the same form as the last year. My clock has been kept

going on, without any alteration of any kind : it is only by long and uninterrupted trials, that any judgement can be formed concerning the cause of errors.

The three first months of the following tables are, perhaps, less accurate than they might have been. I was absent from home great part of that time ; and could only take such observations as occurred when I was occasionally in the country : hence the thermometer and barometer might be either higher or lower, in any of those months, than I have here set them down. I could truly give none but what I observed.

In the course of the summer I received from Mr. Nairne a Smeaton's *hygrometer*, which I had ordered the year before. I did not get it adjusted to my mind till the beginning of August ; but from that time, have added its highest and lowest state in each month, to those of the thermometer and barometer. Its situation is the same as that of the clock itself ; being fastened against the same wall, and close by its side. I do not apprehend the rod of the pendulum to be affected by sudden or small changes in the degree of humidity of the air ; though it seems to be so by a long continuance of damp or dry weather. The hygrometer may perhaps shew that. The general dryness of summer, and the thickening of the oil in winter, (as far as I have had opportunity for trial) I take to be the principal causes of the change of rate in such a clock as mine. It now throws out rather less than it did : perhaps owing to its being less clean, or to the drying of the oil.

1772.	Clock + too fast — too slow for mean sol. time.	Gain + or Loss —	Num- ber of days.	Rate per day.	Throwing out	
					South side.	North side.
			"	"	0 1	0 1
Nov. 2	Clock + 15 13,0	+ 25,9	12	+ 2,15	1 45	1 48
14	+ 15 38,9	+ 24,6	35	+ 0,70	1 46	1 48
Dec. 19	+ 16 3,5	+ 16,9	22	+ 0,77		
1773.						
jan. 10	+ 16 20,4	+ 1,9	20	- 0,095	1 43	1 45
30	+ 16 18,5	+ 0,8	4	+ 0,20	1 38	1 42
Feb. 3	+ 16 19,3	+ 4,0	27	+ 0,15	1 39	1 42
Mar. 2	+ 16 23,3	+ 5,3	11	+ 0,48		
13	+ 16 28,6	+ 16,9	16	+ 1,06		
29	+ 16 45,5	+ 35,5	12	+ 2,96		
Apr. 10	+ 17 21,0	+ 40,2	14	+ 2,87	1 37	1 40
24	+ 18 1,2	+ 21,2	7	+ 3,03		
May 1	+ 18 22,4	+ 38,2	9	+ 4,24	1 42	1 45
10	+ 19 0,6	+ 80,8	19	+ 4,25		
29	+ 20 21,4	+ 39,3	10	+ 3,93		
June 8	+ 21 0,7	+ 45,5	11	+ 4,14	1 44	1 46
19	+ 21 46,2	+ 53,3	12	+ 4,44	1 46	1 49
July 1	+ 22 39,5	+ 74,6	16	+ 4,06		
17	+ 23 54,1	+ 103,3	20	+ 5,16		
Aug. 6	+ 25 37,4	+ 59,4	11	+ 5,40	1 45	1 48
17	+ 26 36,8	+ 61,7	10	+ 6,17		
27	+ 27 38,5	+ 58,1	10	+ 5,81	1 44	1 47
Sept. 6	+ 28 36,6	+ 57,2	12	+ 4,77		
18	+ 29 33,8	+ 44,1	13	+ 3,39	1 39	1 42
Oct. 1	+ 30 17,9	+ 37,3	15	+ 2,55		
16	+ 30 55,2	+ 27,7	17	+ 1,63	1 35	1 38
Nov. 2	+ 31 22,9	+ 17,8	11	+ 1,62		
13	+ 31 40,7	+ 20,4	23	+ 0,89	1 32	1 35
Dec. 6	+ 32 1,1	+ 18,6	21	+ 0,88		
27	+ 32 19,7					

1772.	Thermometer without doors, exposed to the north.			Therm. near the clock.	Barom. on the ground floor.	Hygrom. near the clock.
	Hor. 8. Mat.	Hor. 2. P. M.	H. 11. P. M.			
Nov.	Highest 46	56	56	52	30,02	
	Lowest 39,5	42	39	44	29,31	
Dec.	Highest 49	51	48	50	30,20	
	Lowest 30	33	30,5	34	29,01	
1773.						
Jan.	Highest 50	52	48	58	30,15	
	Lowest 30	34	21	34	28,56	
Feb.	Highest 48	50	48	48	30,42	
	Lowest 23	31	22	29	28,44	
Mar.	Highest 53	65	48	55	30,26	
	Lowest 33	39	31	40	29,58	
April	Highest 53	63	48	53	30,27	
	Lowest 40,5	44	35	48	28,82	
May	Highest 61	70	57	57	30,19	
	Lowest 42	41	33	45	29,19	
June	Highest 70	74	61	64	29,99	
	Lowest 48	54	43	52	29,18	
July	Highest 71	77	65	65	30,18	
	Lowest 52	57	48	55	29,58	
Aug.	Highest 71	82	64	69	30,06	23
	Lowest 55	61	50	54	29,11	9,5
Sept.	Highest 64	66	59	60	29,97	39
	Lowest 48	52	47	49	29,045	15
Oct.	Highest 59	62	58	55	30,16	39
	Lowest 42	49	40	47	28,95	20
Nov.	Highest 49	54	52	50	30,09	63
	Lowest 30	33	30	38	28,42	20
Dec.	Highest 48	50	47	46	29,97	67
	Lowest 28	36	27	36	28,86	30

Occultations of Stars by the Moon. Observed with a $3\frac{1}{2}$ -feet achromatic telescope, magnifying 150 times.

1773.		App. time.	
12 Feb. 6.	☽ 2 ad. α 25	6 37 20	Im. Perhaps 1" sooner. ☽ nearly full, and a protuberance just at that part of her ragged edge which seemed to mislead me.
♀ Feb. 26.	☽ * (No 53 of La Caille, I believe.)	7 38 48 9 4 59 9 56 50	Em. good. Dark limb, * began to lose some of its light 9" before it disappeared. Em. doubtful. ☽ low, and great undulation. Em. perhaps 20" sooner.
♂ Sept. 7	☽ Aldebaran	20 48 39,5	Im. very good. Alt. about 35° . Em. rainy.
☽ Nov. 1.	☽ Aldebaran	9 13 44 10 13 3	Im. very good. Light limb. Alt. $25^{\circ} 30'$. Em. It might perhaps be 1" sooner, but not more. Alt. $35^{\circ} 15'$.

I have observed many other occultations of small stars; but, as their emersions were scarcely visible, and probably there have been no corresponding observations, I suppose it can be of no use to record them.

ECLIPSES OF JUPITER'S SATELLITES: observed
with the same telescope, magnifying 100 times.

In these eclipses, I have endeavoured to make use of the method recommended by M. BAILLY, in a paper communicated to this society the last year, and printed in our Transactions, Vol. LXIII. p. 185. The diameter of the aperture of my telescope is 3,6 inches; and the diaphragms I have made, have their apertures differing from each other in diameter, as near as may be, $\frac{1}{10}$ th of an inch. When the air is steady for any continuance, and uninterrupted with clouds, even though it be not perfectly clear, I should apprehend this method may be of considerable use in reducing the observations of different persons to some standard: but when there are flying clouds, or any changes in the atmosphere, during the observation, it cannot be satisfactory; and at such times may be scarce worth attempting; unless for the sake of rendering such practitioners as myself more expert, when the air is more favourable to their endeavours.

I have, in some of these eclipses, as well as the preceding occultations, set down the altitude of the object; as that may sometimes be of use, in considering the state of the observation. But it should be remembered, that these altitudes are not taken with any great precision. In these eclipses, as in the occultations, I have suppressed those observations which appeared doubtful: they tend only to mislead.

1772.		App. time.	
5 Nov. 14.	First sat.	5 59 44	Em. good. inches.
1773.			
Aug. 8.	Third sat.	11 15 ±	Invisible 0,4 aperture.
		11 24 23	Im. 0,6
		11 31 10	Im. 3,6, or whole aperture. Observation good. Night clear. 24 Alt. 21°.

This being the first trial of the diaphragms, and the evening favourable, I tried the effect of them upon the other satellites.

		inch.	inch.
Second sat. near 24	invisible	0,8	visible 0,9
Fourth sat.	scintillation	0,4	visible 0,5
Aug. 31.	First sat.	9 40 ±	Invisible 0,7 aperture.
		9 49 46	Im. 1,0; but <i>quere</i> , I have some suspicion I used 1,2 by mistake; for I found that afterwards in the cap which con- tains the diaph.
		9 51 44	Im. 3,6, or whole aperture. Alt. 20° 20'. Air calm, but not very clear. Distant from 24 32°.
Second sat.	12 35 ±	Invisible 0,7	
	12 43 14	Im. 1,0	
	12 44 51	Im. 3,6	Alt. 39°. Air as before.
First sat.	12 47 8	Em. from behind 24's disc.	
Sept. 20.	Third sat.	11 40 ±	Invisible 0,6; but there were fly- ing clouds at that time, though clear afterward.
		11 46 19	Im. 0,8
		11 51 6	Scintillation.
		11 51 23	Im. 3,6 good. Alt. 39°.

1772.						
h	Oct.	9.	First sat.	10	45	35
				10	47	34
				10	48	49
				10	55	±
5		19	Third sat.	6	33	29
				6	36	28
				6	40	±
8		20.	Second sat.	9	58	19
				9	59	25
				10	0	45
				10	5	±
				Em.	3,6	good.
				Em.	1,5	
				Em.	1,0	
				Invisible	0,7	a little haziness made
						the trial of the
						diaph. uncertain.
				Em.	3,6	good.
				Em.	1,0	
				Invisible	0,5	night clear and still.
				Em.	3,6	good obs.
				Em.	1,0	Alt. 38°.
				Invisible	0,5	
				Em.	0,6	
				Invisible	0,5	

Other Observations, made with the same telescope, magnifying 150 times.

App.time.			
	h	m	s
24 Sept. 2	8	55	o
	II	o	o
			I looked at 24 to observe the shadow of the 2d sat. then on his disc; and thought I saw the sat. itself very visible, though central, and on a bright zone, and much larger than I could expect it to appear; reaching from the middle dark belt, which it indented, across the bright one, and quite into the next dark one. <i>Vide</i> fig. I.
	II	o	o
			I looked again to observe its exit; when I perceived the sat. in a very different part of the disc: and now perceived that what I had seen before, must be a spot on 24 himself; which, though now gone, had been very visible with the power of 100, notwithstanding D was distant from 24 but 6°.
25 Sept. 4	9	50	o
	12	o	o
			Spot seen again, advanced about $\frac{1}{4}$ or more. I was now convinced that the spot was on the disc itself.
			Spot not visible. The southern (or upper) belt appears only on each side; but is discontinued in the middle.

		App. time.	
y Sept. 6.	8 45	o	No spot visible ; nor the belt contiguous to it, that I could perceive. The southern belt now compleat. The 3d sat. just emerged from behind $\frac{1}{4}$.
	11 15	o	Spot appears ; and the northern belt seems to appear about the same time. This belt was continued all round the planet the year before. The lower or northern edge of the middle zone, this year much darker than the southern.
b Sept. 11.	10 44	o	Spot $\frac{1}{2}$ advanced. The 4th sat. in inferior conjunction ; seemingly in contact, but not on the disc. <i>Vide</i> fig. II.
g Oct. 13.	7 30	o	Spot central, as near as I could judge.
g Oct. 15.	9 0	o	Spot almost central ; that is, its preceding edge central. The planet very clear. The middle belt appeared undulated, just as in fig. III.
f Nov. 9.	5 10	o	Spot still visible, about $\frac{2}{3}$ advanced. I have not been able to attend to it since that time.

Since the reading of a Paper, communicated last year to this society by Dr. WILSON, Professor at Glasgow, on the spots of the sun ; who mentions some appearances when they approach the limb, which I thought I had now and then observed ; I have frequently turned my glass that way, as occasion offered, in order to see whether those appearances were constant, or what might be discovered to confirm the hypothesis laid down in the latter part of that paper.

Dr. WILSON, I hope, will excuse me when I say, that the appearance he mentions when the spots approach the sun's limb, as if they were in a cavity on his surface, is not constant. They generally have appeared so to me, I confess. But as they sometimes have not, and as I have very frequently seen

them almost in contact with the limb ; that is, not $\frac{1}{2}$ of a second of time distant in passing a wire, for I have no micrometer ; I think they can scarcely be in such a hollow, below his surface, as the doctor describes. To me, indeed, by the brighter light often adjoining to them when near the limb, they have rather put on the appearance as if they were in the crater of a volcano on the top of an eminence, which then turned its side towards us ; and if so, the spot would appear somewhat nearer to the limb than it actually was. I have, indeed, never seen any protuberance on either limb of the sun, as I have on the moon ; but I have many times observed, near the eastern limb, a bright *facula* just come on, which has the next day shewn itself as a spot ; though I do not recollect to have seen such a *facula* near the western one, after a spot's disappearance. Yet, I believe, both these circumstances have been observed by others ; and perhaps not only near the limbs.

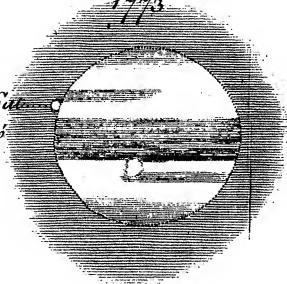
As to the *nebulæ* ; they are certainly not always, though they are usually, quite round each spot, or each cluster of spots ; neither are they always externally convex. The spot, fig. IV. which I saw Nov. 13, nearly in the centre of the sun, is a remarkable instance of the contrary. Nothing therefore can be concluded from that circumstance. Besides, spots are sometimes quite without any *nebulæ* at all ; or none that I could perceive with any power of my glass.

What the spots, or their *nebulæ*, are, I pretend not to guess. To me they appear as if they were adjoining to the surface : though that is doubted by better

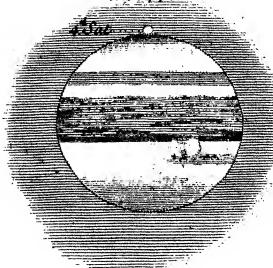
Fig. I Sept. 2.
h. 8.55
1773

2^d Sit.

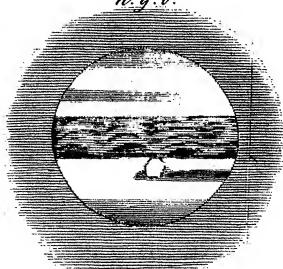
h. 11.5



II. Sept. 11.
h. 10.44



III. Oct. 15.
h. 9.0



IV. Nov. 13. 1773.



better astronomers, who have calculated their motions. The circumstance of the *faculae* being sometimes converted into spots, I think I may be sure of. That there is generally (perhaps always) a mottled appearance over the face of the sun, when carefully attended to, I think I may be as certain. It is most visible towards the limbs; but I have undoubtedly seen it in the centre: yet I do not recollect to have observed this appearance, or indeed any spots, towards his poles. Once I saw, with a 12-inch reflector, a spot burst to pieces while I was looking at it. I could not expect such an event; and therefore cannot be certain of the exact particulars: but the appearance, as it struck me at the time, was like that of a piece of ice when dashed on a frozen pond, which breaks to pieces and slides on the surface in various directions. I was then a very young astronomer; but think I may be sure of the fact. Perhaps I may be thought a young astronomer still, for throwing out these rough observations and crude thoughts: but whatever they be, if my errors shall lead others into enquiries which may be productive of certainty, their end will be answered.

Chislehurst,
Jan. 3, 1774.

FRANCIS WOLLASTON.